

Evaluations Of The Pop Model For Navy Forecasting Use

Julie McClean

Oceanography Department
Naval Postgraduate School
Monterey, CA 93943

phone:(831) 656-2437 fax: (831) 656-2712 email:mcclean@nps.navy.mil

Robin Tokmakian, Mathew Maltrud¹, Albert Semtner, and Wieslaw Maslowski

Oceanography Department
Naval Postgraduate School
Monterey, CA 93943

phone:(831) 656-3255 fax: (831) 656-2712 email:robint@ncar.ucar.edu

phone:(831) 656-3267 fax: (831) 656-2712 email:sbert@ncar.ucar.edu

phone:(831) 656-3162 fax: (831) 656-2712 email:maslowsk@ncar.ucar.edu

¹Los Alamos National Laboratory

Los Alamos, NM 87545

phone:(505) 667-9097 fax: (505) 665-5926 email:maltrud@lanl.gov

Award #: N0001499WR30149

http://www.oc.nps.navy.mil/~braccio/pop_eval/

LONG-TERM GOALS

Development of a global high resolution atmosphere/ocean/ice coupled model with data assimilative capability for use in Navy forecasting.

OBJECTIVES

The overall objective is to evaluate the feasibility of using the high resolution Los Alamos National Laboratory (LANL) Parallel Ocean Program (POP) for global Navy forecasting needs. Particular objectives are to assess the ability of the model to reproduce processes and features of importance to prediction at 1/10-degree horizontal resolution and 40-level vertical resolution in a basin-scale simulation, and to determine the impact of various samplings of wind forcing on the realism of a global 1/3-degree, 32-level run.

APPROACH

The POP model is a multilevel, primitive equation model derived from Bryan's [1969] code and other versions [Semtner, 1997]. It was restructured for use on massively parallel computers by LANL investigators; 1/6-degree near-global [Maltrud et al., 1998] and 1/10-degree North Atlantic [Smith et al., 1999] runs were subsequently performed. A global, 2/3-degree configuration of the POP model with a displaced North Pole grid forms the ocean component of the coupled atmosphere-ocean-ice Parallel Climate Model (www.cgd.ucar.edu/ccr/pcm/new_update/index.html). In June 1999, an updated version of POP was released (climate.acl.lanl.gov), coinciding with the adoption of POP by NCAR as the ocean component of the Climate System Model.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 30 SEP 1999		2. REPORT TYPE		3. DATES COVERED 00-00-1999 to 00-00-1999	
4. TITLE AND SUBTITLE Evaluations Of The Pop Model For Navy Forecasting Use				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School,Department of Oceanography,Monterey,CA,93943				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Two configurations of the POP model, forced with 1993-1997 Navy Operational Global Atmospheric Prediction System (NOGAPS) wind stresses, are used to address the feasibility of using POP in a global predictive system. Tokmakian is running a 1/3-degree, 32-level, global displaced North Pole grid configuration. Following this 5-year simulation, she will run several short simulations to evaluate the impact of different temporal samplings of the wind stresses on the realism of the model solution. The model was initialized from a 30-year POP run forced with climatological European Centre for Medium-Range Forecast (ECMWF) winds followed by 15 years of realistic ECMWF fluxes.

McClean is running a 1/10-degree, 40-level North Atlantic basin configuration. She is examining the ability of the model to reproduce features and processes of importance to operational needs at this resolution. Computer resources are currently unavailable to perform a global simulation at this resolution, however as we look forward to such a time, the North Atlantic simulation provides a proof of concept in a data-rich basin relative to much of the rest of the global ocean. Maltrud collaborated with McClean to set up and test this run; the latest release of POP is used. The run was initialized from a 15-year ECMWF-forced North Atlantic run [Smith et al. 1999]. Both models include the Large et al. [1994] K-Profile Parameterization (KPP) mixed layer formulation.

Both simulations are being evaluated using high-frequency sampled data and similarly configured runs forced with ECMWF winds. The data comparisons (although sometimes sparse) provide a quantitative measure of the skill of the particular model. The intercomparisons of the similarly configured runs provide a measure of any unrealistic aspects of the model introduced by the forcing fields.

In particular, output from the global run will be compared with sea surface height (SSH) and sea surface temperature (SST) data from satellites, SSH from global tide gauges, temperature, salinity, and velocity from the Tropical Atmosphere Ocean (TAO) array in the equatorial Pacific and from Ocean Weather Stations in the Pacific and Atlantic. Tokmakian performs these evaluations.

In the North Atlantic, evaluation measures drawn up the DAMEE-NAB North Atlantic program will be calculated. These include the transports through key passages such as the Florida Straits, statistics related to the variability of the position of the north wall of the Gulf Stream, high-frequency variability of the Deep Western boundary current, and Gulf Stream meander/eddy behavior. Also Lagrangian and Eulerian statistics calculated from the North Atlantic World Ocean Circulation Experiment (WOCE) surface drifter data set will be compared with statistics from the 1/10-degree run and from the earlier 1/6-degree, 20-level near-global simulation. The role of increased resolution can be assessed along with model performance. Over key continental locations, the role of wind forcing on SSH will be determined and the results compared with those from Jacobs [1998] using altimetry data. McClean is largely responsible for the North Atlantic evaluations. An M.S. student at NPS, Pelton, is calculating the drifter statistics with input from Poulain (NPS). Jacobs (NRL Stennis) and McClean will assess model SSH performance over continental shelves collaboratively. Visualization and web support are provided by Braccio (NPS).

WORK COMPLETED

Surface forcing fields were created from the output of the NOGAPS atmospheric model stored at NRL Stennis (Posey, pers. comm. 1999) for the global and North Atlantic runs for 1993-1997 by Sirayanone.

Two years of the global run have been completed, with the evaluation of the three-day output being conducted currently to verify the the correct values of the horizontal and vertical mixing parameters. One year of the North Atlantic run is complete. This is a spinup year to accommodate the switch in wind fields from the ECMWF run to the NOGAPS run. Visualization of the output along with diagnostics have been used to check that the model is spinning up appropriately with the new winds fields. The model has been transitioned to the Origin 2000 at the the Army Research Laboratory to take advantage of our newly awarded status as Department of Defense High Performance Computing Grand Challenge users.

Lagrangian and Eulerian statistics from the North Atlantic surface drifter set and the 1/6-degree POP output have been calculated for 1993-1997. Data is subsampled to match the times of the daily model snapshots. Model trajectories were calculated using a Runge-Kutta scheme.

RESULTS

A movie of the global 1/3-degree model SSH is found at www.oc.nps.navy.mil/~braccio/pop_eval; features observed by altimeters are seen in the model fields such as Agulhas eddies forming south of Africa and Kelvin waves propagating across the Pacific. The root mean square of SSH from the last six months of 1993 is shown in Figure 1 for the NOGAPS (upper panel) and ECMWF (lower panel) runs. No mixed layer is present in the ECMWF simulation; mixing parameters are the same in the two runs. The patterns of variability are very similar with the NOGAPS simulation being slightly more energetic, possibly a result of the mixed layer.

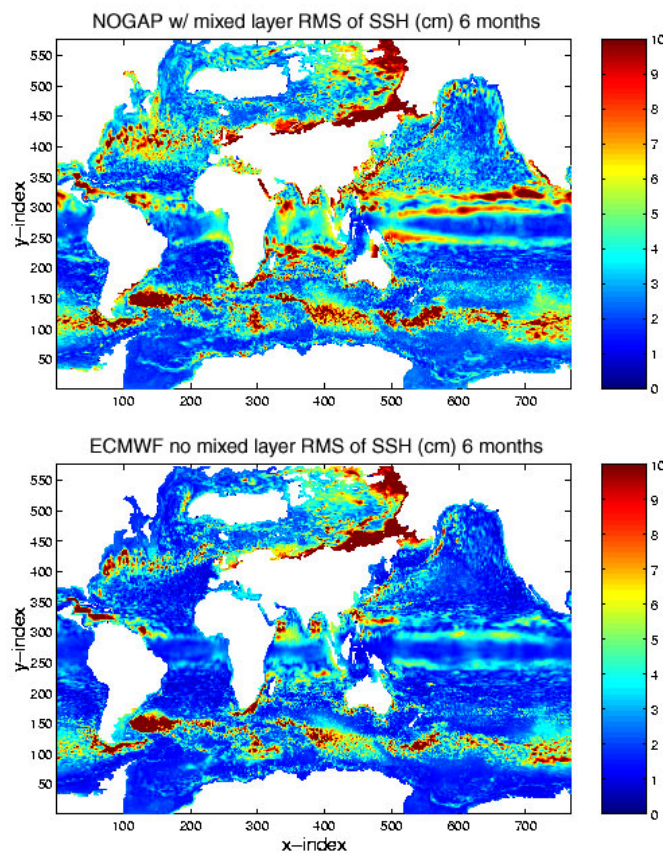


Figure 1

Movies of the North Atlantic spinup can similarly be viewed at the afore-mentioned web site. One of the fields saved daily is the depth of the 15-degree isotherm at about 200 m; a measure used to define the position of the north wall of the Gulf Stream. Figure 2 shows a snapshot of this field in mid-June 1993; the 15-degree isotherm shows the meandering of the north wall as well as the formation and shedding of cold and warm core eddies. Figure 3 shows snapshots of mixed layer depth from (a) mid-October and (b) mid-December, 1993. Mixed layer depths are seen to increase with the transition into winter.

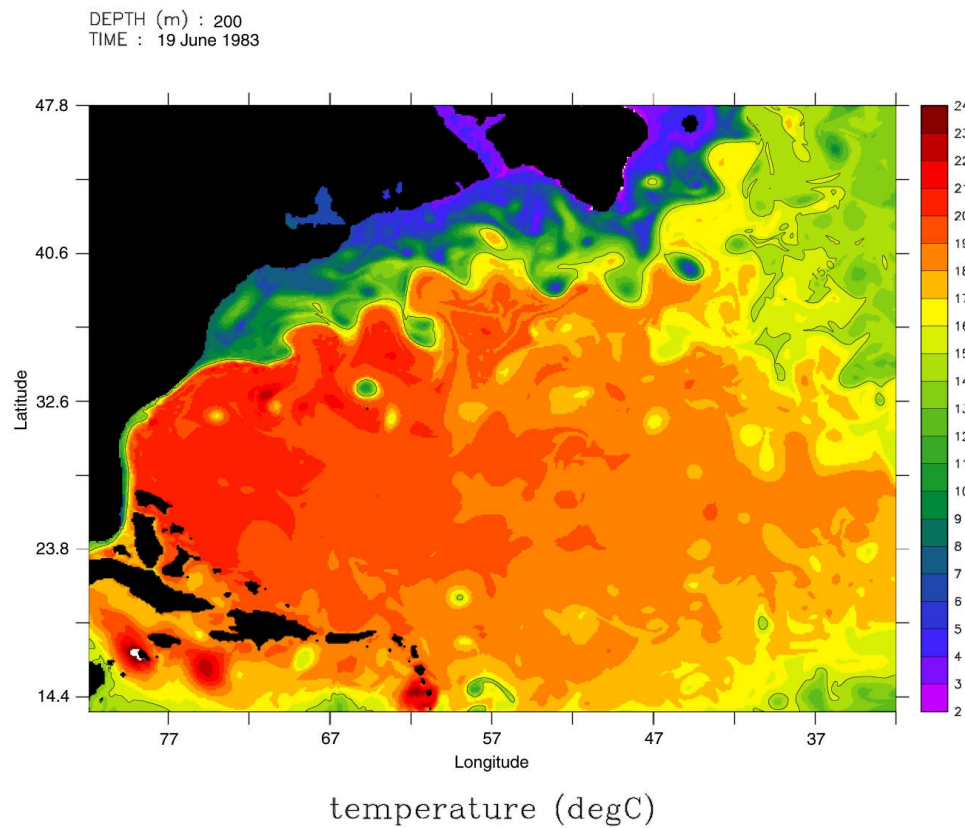


Figure 2

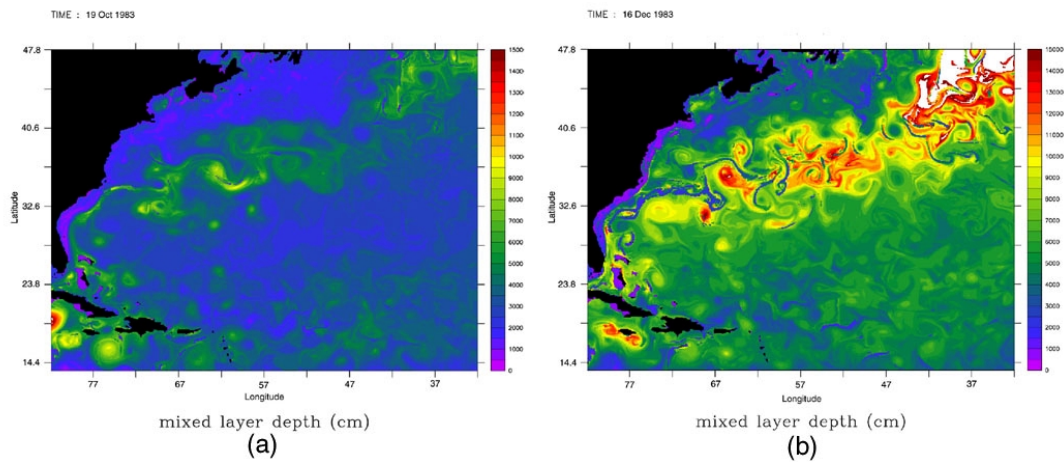


Figure 3

IMPACT/APPLICATION

These evaluations will provide an assessment of the potential usefulness of this model in a Navy predictive system. Together with experience gained using the new release of POP, these findings will provide a basis for the configuration of a very-high resolution global ocean model that will eventually be coupled to atmospheric and ice components.

TRANSITIONS

Output from these runs can be made available to other investigators. Chui (NPS) and McClean will explore the possibility of evaluating the model in terms of acoustic quantities.

RELATED PROJECTS

A version of NOGAPS that runs on scaleable architecture is being developed at NRL by Rosmond (NRL). At NPS and NRL, the development of a new Arctic ice-ocean prediction system is underway. The ice and atmospheric models are likely to be components of the fully coupled prediction system.

REFERENCES

Bryan, K., 1969: A numerical method for the study of the circulation of the world ocean. *J. Comput. Phys.*, 4, 347-376.

Large, W. G, J. C. McWilliams, and S. C. Doney, 1994: Oceanic vertical mixing: A review and a model with a nonlocal boundary layer parameterization. *Rev. Geophys.*, 32(4), 363-403.

Maltrud, M. E., Smith, R. D., R. C. Malone, and A. J. Semtner, 1998: Global eddy-resolving simulations driven by 1985-94 atmospheric fields, Part I: mean circulation and variability. *J. Geophys. Res.*, 103, 30,825-30,853.

Semtner, A. J., 1997: Introduction to "A numerical method for the study of the circulation of the world ocean". *J. Comp. Phys.*, 135, 149-153.

Smith, R. D., M. E. Maltrud, F. O. Bryan, and M. W. Hecht, 1999: Numerical simulation of the North Atlantic at 1/10-degree. *J. Phys. Oceanogr.*, accepted.